Resuscitation in the Emergency Department

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Isolated Traumatic Brain Injury ("TBI") vs. Multi-trauma

- **Approach to the patient with isolated head injury is markedly different from the patient with multi-system trauma**
- **Isolated TBI – need to maximize cerebral perfusion**
- **Multi-trauma – permissive hypotension may be the goal**

Traumatic Brain Injury

- **Cerebral Perfusion Pressure (CPP) is an estimate of the adequacy of blood flow to the brain**
- **CPP=MAP-ICP**
- **MAP = DBP + 1/3 (pulse pressure)**
- **Goal is to keep CPP > 70 mm Hg**
- **Mortality ↑ ~ 20% for each 10mmHg ↓ of CPP**
- **Optimize CPP by ↓ ICP or ↑ MAP**

Goals to Preserve Brain Function

- **CPP**
- **ICP**
- **MAP**
- **Oxygenation**
- **Sedation/analgesia**
- **Seizure prophylaxis**
- **Volume status**

- CPP 70-80 mm Hg
- ICP < 20 mm Hg
- MAP > 70 /SBP > 90
- $SaO_2 \geq 90\%/PaO_2 > 60$ mm Hg
- Ramsay Sedation Scale/VS
- DPH or levetiracetam load
- CVP 8-15/HR/MAP/UOP >0.5mL/kg/hr

Decreasing ICP

- ↓ intracranial volume
- -evacuation of hematoma
  -removal of CSF via ventriculostomy
- These are not effective for ↑ ICP due to cerebral edema
- Osmotic agents remove edema fluid
- ↑ serum osmolality draws fluid from interstitial space of brain parenchyma into vascular space, which is then removed from cranium into general circulation

Hypertonic Saline

- **Rapid osmotic mobilization of cellular water into blood volume**
- **Expands intravascular volume 4-10x greater than the infused volume**
- **Evolving literature mixed for patients with head injury**
- **HTS ↓ ICP without compromising CBF**
- **HS may be superior to NS or LR for patient with severe head injury**
- **Change in prehospital practice???**

Pre-hospital hypertonic saline resuscitation of patients with hypotension and severe TBI. *NEJM* 2004

- Double blind RCT
- 229 pts with GCS < 9 and SBP < 100
- 250 mL of 7.5% saline or 250 mL of RL
- Survival to discharge similar in both groups
- *No significant difference in favorable neurologic outcomes at 6 months*
- Concluded no statistical benefit from HTS

Pre-Hospital Resuscitation Hypertonic Saline

Study limitations

- Multi-trauma pts (90%) vs. isolated head injury
- Long total prehospital time (60 min)

Hypertonic Saline (HTS)

- **Animal and human studies suggest that HTS is a potential therapeutic agent to assist with medical treatment of pts with TBI.**
- **HTS decreases brain size, predominately uninjured brain, and has several potential advantages over mannitol.**
- **Animal studies support its use, but definitive human trials using mortality end points in brain trauma are lacking.**
- **HTS may be considered a therapeutic adjunct to the medical management of TBI, awaiting definitive evidence to support routine use.**

Multisystem Trauma

- **May require blood pressure support for major fractures and closed head injury**
- **Need to maintain cerebral perfusion pressure in face of systemic hypotension**
- **Solid organ injury bleeding may be accelerated**
- **Role of permissive hypotension**

Permissive Hypotension

- What about patients with TBI?

Multidisciplinary approach

- Coordination of ED, ACS, and Neurosurgery
- Organized approach
- Primary survey
- ABCDEF
- Rule out other life threats
  - Chest, abdomen, pelvis
  - FAST exam

Trauma Resuscitation

- **C-spine concerns**
- **Blood and secretions in airway**
- **Concern for ↑ ICP with laryngoscopy**
- **Intubation often difficult or impossible with additional meds (RSI)**
- **No studies showing benefit from pre-hospital intubation of trauma patients**

Rapid Sequence Intubation (RSI)

- Controlled use of paralytic and other adjunctive agents to facilitate intubation
- Offers the ability to control an unstable and deteriorating airway
- Widely accepted in most EDs
- Varied use in prehospital setting
- Air ambulances vs. ground transports

Sedation for combative TBI patients

- RSI vs. sedation
- Index of suspicion for ICH
- Sedatives
  - Haloperidol +/- benzodiazepines +/- anticholinergics
  - Opiates, benzos

    -fentanyl, benzos
  - Ketamine
    - New literature has dispelled previous concerns for ↑ ICP
    - *May be ideal for patients already hypotensive*

Cervical Spine precautions

- **Always assume concurrent c-spine injury with serious TBI**
- **In-line stabilization**
- **Fiberoptic intubation vs. direct laryngoscopy**
- **Steroids(?)**

Spinal Cord Injury

Management Principles

- **Ensure adequate oxygen delivery and blood flow**
- **Early surgical intervention with spine reduction, stabilization and fixation coupled with spinal cord decompression and restoration of spinal canal dimensions.**

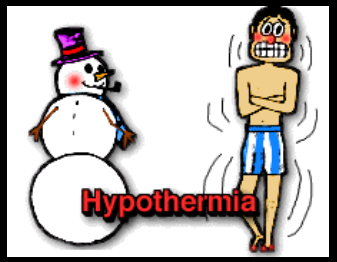
~~Steroids for SCI~~

- **After publication of the 2nd 'National Acute Spinal Cord Injury Study' (NASCIS-2) in 1990, the application of high-dose steroids for pts with acute SCI became a globally accepted "standard of care" for more than a decade**
- **Administration of methylprednisolone for treatment of SCI is *not recommended***
  - **Not FDA approved for SCI**
  - **No Class I or Class II medical evidence to support clinical benefit of MP in SCI**

- **Class I, II, and III evidence exists that high-dose steroids are associated with harmful side effects, including an ↑ incidence of infection, sepsis, complications and increased intensive care unit length of stay, and death with its use. (level I evidence)**

  – Introduction to the Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injuries
  Neurosurgery March 2013

Hypothermia for SCI



- Systemic hypothermia has been investigated for decades as a noninvasive modality of neuroprotection for patients with head injuries, CVA, cardiac arrest and SCI
- Hypothermia slows down the acute inflammatory processes in the injured CNS and may ↓ the extent of traumatic and ischemic tissue injury
- Currently a *lack* of scientific evidence from controlled clinical trials in humans
- Systemic hypothermia has to be considered a pure empirical and experimental treatment option, despite anecdotal testimonies for its clinical application

Hypothermia Therapy after Traumatic Brain Injury in Children

***NEJM* 2008**

- **In a multicenter, international RCT**
- **Children with severe TBI (GCS < 9) rec'd either hypothermia therapy (32.5°C for 24 hours) or normothermia (37.0°C).**
- **The primary outcome was the proportion of children who had an unfavorable outcome (i.e., severe disability, persistent vegetative state, or death), as assessed on the basis of the Pediatric Cerebral Performance Category score at 6 months.**

Hypothermia Therapy after Traumatic Brain Injury in Children

- **At 6 months, unfavorable outcome in 31% of the patients in the hypothermia group vs. 22% in the normothermia group (RR 1.41; P=0.14).**
- **There were 23 deaths (21%) in the hypothermia group vs. 14 (12%) in the normothermia group (RR 1.40 P=0.06).**
- **There was more hypotension (P=0.047) and more vasoactive agents were administered (P<0.001) in the hypothermia group during the rewarming period than in the normothermia group..**

Conclusions

- ***In children with severe traumatic brain injury, hypothermia therapy that is initiated within 8 hours after injury and continued for 24 hours does not improve the neurologic outcome and may increase mortality***

ICP monitoring in the ED

- **Although ICP-based management in severe TBI is widely accepted, results from non-randomized observational studies are inconsistent.**

A Trial of Intracranial-Pressure Monitoring in Traumatic Brain Injury

NEJM 2012

- **Multicenter RCT of 324 patients ≥ age 13 with severe TBI treated in ICUs in Bolivia or Ecuador**
- **Guidelines-based management in which a protocol for monitoring ICP was used (ICP monitor group) or a protocol in which treatment was based on *imaging and clinical examination***
- **The primary outcome was a functional status at 3 and 6 months**
- **There was no significant between-group difference in functional and cognitive status between two groups (P=0.49).**
- **Six-month mortality was 39% in the ICP monitor group and 41% in the imaging–clinical examination group (P=0.60).**
- **The distribution of serious adverse events was similar in the two groups.**

A Trial of Intracranial-Pressure Monitoring in Traumatic Brain Injury

NEJM 2012

Conclusions

- **Care for severe TBI patients focused on maintaining monitored ICP ≤ 20 mm Hg was not shown to be superior to care based on imaging and clinical examination.**
- **These results, the investigators say, "do not support the superiority" of treatment based on ICP monitoring over treatment guided by neurologic testing and serial CT imaging in improving short-term and long-term recovery in the general population of patients with severe TBI.**

DEM Resuscitation Summary

- **Resuscitate *the patient* in order to resuscitate the brain**
- **Assume SCI in patients with severe TBI**
- **Hypotension and hypoxia (even brief) significantly worsen outcome**
- **Multi-trauma with TBI is a “Team Sport”**

DEM Resuscitation

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Thank You